CLAIMS

1. A USB compound device, utilized to connect a plurality of function devices to a USB Bus and make the connected function have the advantage of "plug-and-play" function, comprising:

a USB transceiver for utilizing as the connection point between the plurality function devices and the USB Bus, transmitting signals to or receiving signals from the USB Bus and performing the signal format conversion;

a serial interface engine (SIE) for decoding the signals received from the USB Bus and then transforming them from serial form into parallel form, coding the signals to be transmitted to the USB Bus after transforming them from parallel form into serial form, and performing cyclic redundancy check code inspection while transmitting/receiving; and

a circuitry for storing and managing a plurality of device addresses designated by a USB host, and proceeding with data transmission, wherein said circuitry does not have the functions of said USB transceiver and said SIE, and its one terminal is connected to said SIE while the other terminal is connected to a plurality of non-USB interfaces, which are used to connect to the plural function devices, via a microprocessor or controller.

2. The USB compound device as described in claim 1, wherein the circuitry comprising:

a generic endpoint state machine;

an address/endpoint management mechanism for storing a plurality of address/endpoint configurations, wherein said USB compound device executes USB standard communication protocols to communicate with the USB host via said generic endpoint state machine according to the types of the endpoints stored in said address/endpoint management mechanism; and

a memory module for temporarily storing data being transmitted.

3. The USB compound device as described in claim 2, wherein the plurality of address/endpoint configurations stored in said address/endpoint management mechanism include a set of address/endpoint configuration of a virtual hub, said set of address/endpoint configuration of the virtual hub is used by said circuitry when it executes the function as a hub via said USB transceiver, said serial interface engine and said microprocessor or controller.

4. The USB compound device as described in claim 2, wherein said circuitry further comprising:

an endpoint variable register for storing the states of the plural endpoints, said endpoint variable register is accessed and updated by said generic endpoint state machine.

5. The USB compound device as described in claim 4, wherein said memory module comprising:

a memory buffer for temporarily storing the data being transmitted; and

a memory management unit for accessing data from said memory buffer, comprising:

a memory configuration mechanism of endpoint for storing the memory allocation data and the maximum packet sizes of the endpoints in said memory buffer; and

a memory access control unit for accessing data from said memory buffer according to the endpoint numbers of signals and the memory allocation data stored in said memory configuration mechanism of endpoint.

6. The USB compound device as described in claim 5, wherein said circuitry further comprising:

an application interface engine for transmitting signals and accessing data between said generic endpoint state machine, said memory access control unit, and the plural non-USB interfaces connected with said circuitry.

7. The USB compound device as described in claim 2, wherein said address/endpoint management mechanism comprising:

an address/endpoint configuration mechanism for storing a plurality of logical addresses designated by a USB host, and the correlation between logical endpoints and physical endpoints of each logical address; wherein said generic endpoint state machine utilizes said plural logical addresses to determine whether the plural function devices connected with said USB compound device are the receivers or senders designated by the USB host;

a physical endpoint configuration mechanism for storing the type, the maximum packet size, and the memory allocation data in said memory module of each physical endpoint; and

a logical/physical translation module for translating the logical/physical endpoints of the plural function devices connected with the USB compound device.

8. The USB compound device as described in claim 7, wherein the plural logical addresses and correlation stored in said address/endpoint configuration include a set of logical address of a virtual hub and the correlation between the logical endpoints and physical endpoints thereof, wherein the address/endpoint configuration of said virtual hub is used by said circuitry when it executes the function as a hub via said USB transceiver, said serial interface engine and said microprocessor or

controller.

9. The USB compound device as described in claim 7, wherein said circuitry further comprising:

an endpoint variable register for storing the states of the plural endpoints, wherein said endpoint variable register is accessed and updated by said generic endpoint state machine.

10. The USB compound device as described in claim 9, wherein said memory module comprising:

a memory buffer for temporarily storing the data being transmitted; and

a memory management unit for accessing data from said memory buffer, comprising:

a memory configuration mechanism of physical endpoint for storing the memory allocation data and the maximum packet sizes of the physical endpoints in said memory buffer; and

a memory access control unit for accessing data from said memory buffer according to the physical endpoint numbers of signals, and the memory allocation data stored in said memory configuration mechanism of physical endpoint..

11. The USB compound device as described in claim 10, wherein said circuitry further comprising:

an application interface engine for transmitting signals and accessing data between said generic endpoint state machine, said memory access control unit, and the plural non-USB interfaces connected with said circuitry.

12. The USB compound device as described claim 11, wherein said application interface engine comprising:

an event control module for receiving the events generated by said generic endpoint state machine and said memory access control unit during communication, and transmitting the events to the devices corresponding to said physical endpoint numbers; and

a control interface module for controlling or configuring the registers inside the circuitry, and proceeding with data transmission with the memory control unit;

a data path module for accessing mass data, wherein said data path module transmits data between said memory buffer and the plural interfaces connected with said circuitry in a direct memory access (DMA) manner.

13. A circuitry in the USB compound device as described in claim 1, wherein the circuitry includes:

a generic endpoint state machine;

an address/endpoint management mechanism for storing a plurality of address/endpoint configurations, wherein the USB compound device executes USB standard communication protocols to communicate with the USB host via said generic endpoint state machine according to the types of the endpoints stored in said address/endpoint management mechanism; and

an endpoint variable register for storing the states of the plural endpoints, said endpoint variable register is accessed and updated by said generic endpoint state machine.

14. The circuitry as described in claim 13, wherein said circuitry includes:

a memory buffer for temporarily storing the data being transmitted; and

a memory management unit for accessing data from said memory buffer, comprising:

a memory configuration mechanism of endpoint for storing the memory allocation data and the maximum packet sizes of the endpoints in said memory buffer; and

a memory access control unit for accessing data from said memory buffer according to the endpoint numbers of signals, and the memory allocation data stored in said memory configuration mechanism of endpoint.

15. The circuitry as described in claim 14, wherein said circuitry includes:

an application interface engine for transmitting signals and accessing data between said generic endpoint state machine, said memory access control unit, and the plural non-USB interfaces connected with said circuitry.

16. The USB compound device as described in claim 6, wherein said USB compound device includes a microprocessor.

17. The USB compound device as described in claim 6, wherein said USB compound device includes a controller.

18. The USB compound device as described in claim 12, wherein said USB compound device includes a microprocessor.

19. The USB compound device as described in claim 12, wherein said USB compound device includes a controller.

20. The USB compound device as described in claim 6, wherein said USB transceiver, said serial interface engine and said circuitry are all fabricated on the same single chip.

21. The USB compound device as described in claim 12, wherein said USB transceiver, said serial interface engine and said circuitry are all fabricated on the same single chip.

22. The USB compound device as described in claim 6, wherein said USB compound device further comprising:

a repeater for transmitting upstream and downstream USB signals between a USB host and the USB function devices connected with said USB compound device; and

a connection/removal detecting circuit for detecting connections or removals of a plurality of USB ports, wherein said repeater and said connection/removal detecting circuit enables said USB compound device to provide the plural USB ports.

23. The USB compound device as described in claim 12, wherein said USB compound device further comprising:

a repeater for transmitting upstream and downstream USB signals between a USB host and the USB function devices connected with said USB compound device; and

a connection/removal detecting circuit for detecting connections or removals of a plurality of USB ports, wherein said repeater and said connection/removal detecting circuit enables said USB compound device to provide the plural USB ports.

24. A method of enabling a plurality of function devices to connect to a USB host with the same set of endpoint numbers and have their respective and independent USB addresses, comprising the following steps:

configuring the logical endpoints and the correlation between the logical/physical endpoints of the plural function devices in sequence;

storing the configurations of the physical endpoints of the plural function devices;

initiating the address/endpoint configurations of the plural USB function devices and communicating with the USB host in sequence by utilizing a microprocessor or controller, and then designating the plural function devices their respective USB logical addresses by the USB host;

storing the USB addresses designated by the USB host;

comparing the specific address of each signal transmitted from the USB Bus with the USB logical addresses;

proceeding with logical/physical endpoint translation when the comparison matches; and

transmitting the signal to the function device represented by the physical endpoint.

25. A method for implementing a virtual hub, comprising the following steps:

using an address/endpoint configuration as the USB address/endpoint configuration of the virtual hub;

receiving signals from or transmitting signals to a USB host by using a USB transceiver;

using a serial interface engine to execute the decoding, encoding and format translation of the transmitted signals, and perform cyclic redundancy check code inspection while transmitting/receiving data;

using a microprocessor or controller to communicate with the USB host in the function of a hub via software or firmware, and getting a USB address of said virtual hub from the USB host;

when the address of the transmitted signal directs to said virtual hub, responding to the USB host with the microprocessor or controller according to the content of the transmitted signal; and

managing other USB function devices or reporting the configurations thereof back to the USB host with the microprocessor or controller via software or firmware so as to maintain the USB tiered-star topology.

26. A method for implementing a USB compound device, wherein said compound device is used to connect at least two function devices having no USB logic circuits to a USB Bus, and enable the connected function devices to have the plug-and-play function, said method comprising the following steps:

setting up a physical layer block for connecting to the USB Bus and proceeding with the reception or transmission of signals, format translation, coding or decoding, and cyclic redundancy check code inspection;

setting up a link layer block for receiving the signals transmitted from said physical layer, proceeding the comparison of address/endpoint and communicating with the USB host under communication protocols according to the states of the endpoints;

setting up a memory management unit for receiving endpoint numbers from said link layer and proceeding with data accessing according to the endpoint numbers;

setting up an application interface engine for receiving the signals from said link layer block and said memory management unit, and executing the signals or data transmission with an application unit; and

setting up a memory buffer for storing the temporary data of the endpoints.

27. The method as described in claim 26, wherein the step of setting up said physical layer block comprising:

using a USB transceiver to transmit or receive signals and perform the conversion of signal format; and

using a serial interface engine to execute the decoding, encoding and format translation of the transmitted signals, and perform cyclic redundancy check code inspection while transmitting/receiving data.

28. The method as described claim 26, wherein the step of setting up said link layer block comprising:

storing the states of the endpoints of the connected USB function devices by an endpoint variable register,

using a generic endpoint state machine to access and update said endpoint variable register and communicate with the USB host under USB standard protocols according to the types of the endpoints;

storing the addresses designated by the USB host and the corresponding endpoints of the function devices by an address/endpoint configuration mechanism;

storing the physical endpoints and its endpoint configurations by a physical endpoint configuration mechanism; and

executing the translation of logical endpoints and physical endpoints by a logical/physical

endpoint translator.

29. The method as described in claim 26, wherein the step of setting up said memory management unit comprising:

storing the memory buffers designated to the physical endpoints and the states of the data thereof by a memory configuration mechanism of physical endpoints; and

using a memory access control unit to read the memory buffer blocks and the states of the data thereof from said memory configuration of physical endpoints, and store or read the data into/from the memory buffers thereof.

30. The method according to claim 26, wherein the step of setting up said application interface engine comprising:

using an event control module to receive the events generated by said generic state machine and said memory access control unit during communication and inform the function devices represented by the physical endpoint numbers in said application unit of the event;

using a control interface module to control or configure the register inside said compound device, and proceed with data transmission with said memory management unit; and

using a data path module to access mass data and transmit data between said memory buffers and said application unit in a DMA manner.

31. The method according to claim 26, wherein said method further includes the steps of providing the device a plurality of USB ports, comprising:

using a repeater for transmitting upstream and downstream USB signals between the USB host and the connected USB function devices; and

using a connection/removal detecting circuit to detect connections or removals of the USB ports.